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A Range of Information Test in General Science

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Investigation of the possibilities of a range of information test in general science which could be standardized and used as a quantitative measurement of school attainment in this subject was first attempted by the writer during the school year of 1917-18. At that time it was thought that the best approach to such a test might lie in the collection and comparison of the final examination questions in general science courses in a considerable number of high schools representing the entire country. A little investigation, however, showed that, in spite of the widespread agitation against purely text book courses in science, nevertheless, the textbooks were, in all probability, the best reflection of the prevailing content of such courses. Since a range of information test will necessarily deal almost entirely with the content side of a subject, it was finally decided that the proper procedure would be that of a survey of the existing texts in general science in order to establish the topics characteristic of the present nature of such courses.

These first efforts were interrupted by the war and not until the present time has opportunity for the completion of the test been presented. During the summer session of 1919 the writer's class in the methods of teaching general science completed the analyses of the various texts. In the meantime, Professor Elliot R. Downing of the University of Chicago has published[1] a range of information test covering the entire field of high school science. At first thought it appeared unnecessary to publish the present paper in view of the earlier test. Further examination of the two scales showed that, in reality, there was little or no duplication of purpose involved and that the one might even supplement the other. Several differences of aim, formulation, and scoring are to be noted:

[1] School Science and Mathematics, 1919, 19:228-33.

1. The present test is strictly confined in its application to the one subject of elementary or general science in contrast with the Downing test of the entire field of secondary school science.
2. The present test was assembled upon the basis of frequency of occurrence of the terms in the texts rather than upon a combined use of this method and that of teachers estimates.
3. Much wider use was made of the principle of chance in the final selections in this test.
4. A different method of scoring is advocated.

The exact method of assembling the terms comprising the test was as follows. Somewhat more than twenty text-books and manuals of general science were read through, page by page, and each term which possessed a distinct scientific usage was recorded. In all cases of doubt the word was placed on the record sheet. As far as the writer is aware, no text published since 1912 has been omitted. If a word had a common lay usage as well as a scientific import, it was included in the original lists. The lists for the separate books were then combined on a summary sheet which recorded the exact number of times each term occurred in the twenty odd texts. If then, a word was found to be common to approximately half or more of the texts, it was retained, but if less common, it was disregarded. This last list contained about one hundred and eighty words. From these three lots of fifty words were drawn by numbers. Thus far the entire procedure had been determined by frequency of occurrence and chance selection. Examination of the lists revealed a few obvious irregularities, the elimination of which seemed to involve no escape from certain more or less arbitrary rulings. Therefore, a few arbitrary principles were agreed upon by the members of the class (all being well trained science teachers) as being justified in view of the facts. These are:

1. Owing to the fact that the names of the specific chemical elements are sure to occur rather frequently, and that definitions of such are difficult in any strict sense, it was decided to reject all such except one in each list. The ones retained were those with rather popular commercial uses.

2. The names of the planets were restricted to one on each list.
3. The names of scientists of historical interest were restricted to one on each list (but four such were common enough for acceptance, hence but one was rejected).
4. A very few terms once in strict scientific usage which have become common knowledge were discarded as of little value to a scientific vocabulary test.

The application of the above criteria was limited as far as possible in view of its evident dangers.

The texts considered in making up the lists were:

Barber: First Course in General Science, Holt, 1916

Brownell: Laboratory Lessons in General Science, Macmillan, 1916

Caldwell and Eikenberry: General Science, Ginn, 1914

Caldwell and Eikenberry: General Science (Rev. Ed.) Ginn, 1918

Caldwell and Eikenberry and Pieper: A Laboratory Manual for General Science, Ginn, 1915

Clark: General Science, American Book Co., 1912

Clark: Introduction to Science, American Book Co., 1915

Clark: Laboratory Manual in General Science, American Book Co., 1912

Clute: Experimental General Science, Blakiston

Coulter: Elementary Science, Scribners, 1919

Curtis: Experiments in Elementary Science, Merrill, 1918

Elhuff: General Science, Heath, 1916

Fall: Science for Beginners, World Book Co., 1917

Hessler: The First Year of Science, Sanborn, 1915

Hodgdon: Elementary General Science, Hinds, Hayden, Eldredge, 1918

Lake: General Science, Silver Burdett, 1917

Pease: A First Year Course in General Science, Merrill, 1915

Prucha: Laboratory Exercises in Elementary Science, Scribners, 1919

Rowell: Introduction to General Science, Macmillan, 1911

Smith and Jewett: Introduction to the Study of Science, Macmillan, 1918

Snyder: First Year Science, Allyn and Bacon, 1914

Van Buskirk and Smith: Science of Everyday Life, Houghton Mifflin, 1919

Weckel and Thalman: A Year in Science, Row Peterson Co., 1916

The three lists will permit retesting at very short intervals without loss of accuracy in the results. The exact relative difficulties of the three lists are not yet accurately known. Preliminary use and the chance method of assembling the lists indicate that the differences are not likely to prove significantly great.

There is considerable difference of opinion among investigators as to the best method of scoring definition tests. Professor Downing has used a modification of the method of the Whipple Range of Information test where the subject marks with an "E" the words he can define, "F" for those which are familiar in a general way, and "N" for absolutely new words. In order to check the standard of the judgments of the subject, it has been the usual practice to have the latter write out the definitions for a certain number of the words checked. The scores can thus be weighted by inspection and referred to a uniform standard. The use of this method with very young subjects is open to serious question as the standards of judgment of eighth or ninth grade pupils are widely variant. The method of correction advocated by Professor Downing is more or less uncertain and lacks a completely quantitative basis. For these reasons it was thought better to use a method of scoring replies based upon the correction of the papers by the examiner. The method of Terman and Childs in their vocabulary tests, it is believed, will minimize the personal factors in scoring to a greater degree than will the method of subjects' estimates. Each term acceptably defined is credited with two points, thus making a total of 100 points for each list. A word defined in a manner less than satisfactory but indicating general knowledge of the meaning will be given half credit or one point. Since the terms are all of scientific nature, a reasonably scientific answer must be given for full credit. The chief objection to this method is that it involves much more work on the part of the one giving the tests, but, it is believed that this is more than compensated for by the greater accuracy of the plan of *one mature* scorer rather than a number of less exper-

ienced scorers. Another advantage is the possibility of ali results being rescored by one person.

In giving the tests, the procedure should be substantially as follows : Say, "Here is a list of fifty scientific terms. Explain as many as you can in your own words. Write down your answers as quickly as you can but do not try to abbreviate too much. Try to give a *real* meaning. In some cases the words have both a common and a scientific meaning. In every such case give the *scientific* meaning. If a word has several meanings give the *one* which you can define the best."

There is little necessity for a time limit, although a single class period will usually be sufficient. Needless to say the work of defining the words of the test should be done absolutely independently by the pupils and under the direct supervision of the teacher. Test I should ordinarily be given first. If it is desirable to repeat at a later time with a different list, number II should be used. List III can also be used as an alternate if occasion arises. The suggestion is made that list I be given at the very beginning of the course in general science and again at the close of the course. At the later time one of the other lists may be substituted.

The value of tests of this type is largely a question of norms. The data at hand to date is entirely indadequate, but, it is thought that publication of the tests will result in a much more rapid accumulation of tests than the efforts of a single worker. It is hoped that a number of teachers representative of the country at large will attempt the use of this scale and communicate their results to the writer. Mimeographed sheets giving the tests will be furnished upon request, although, ordinarily, it will prove simpler to write the lists upon the blackboard and allow the pupils to write down each test word preparatory to an attempted definition. A number of teachers throughout this state have signified their intention of making use of this range of information test during the coming school year.

The lists of the final test follow:

List I	List II	List III
alkali	adhesion	abdomen
ampere	altitude	alimentary canal
aneroid barometer	amorphous	amoeba
anther	anti-cyclone	anti-toxin
barometer	Archimedes	barograph
calorie	atom	Centigrade

calyx
capillarity
carbohydrate
cohesion
conduction
digestion
distillation
ductility
eclipse
element
embryo
energy
fertilizer
fungi
fusion
Galileo
gravitation
humus
hypo
igneous
image
Jupiter
lever
longitude
mammal
meter
motor
orbit
oxidation
parasite
photosynthesis
pollination
radiation
respiration
saturation
serum
spore
stamen
tornado
toxin
tungsten
vacuum
volcano
voltaic cell
bituminous
buoyancy
cell
combustion
convection
corolla
cumulus
density
diffusion
dune
effervescence
electrolysis
erosion
ether
ferment
formaldehyde
glucose
gram
induction
inertia
isobar
legume
lodestone
Mars
meteor
mirage
nucleus
organism
ovary
pasteurization
potential energy
precipitate
refraction of light
radium
rotation
siphon
specific heat
spectrum
stomata
thermometer
tissue
vertebrae
watt
weathering
centrifugal force
chlorophyll
constellation
cyclone
dew point
dynamo
disinfectant
electrode
electro-magnet
emulsion
enzyme
evaporization
Fahrenheit thermometer
friction
fulcrum
gastric juice
gland
isotherm
insulator
invertebrate
kinetic energy
latitude
magnet
matter
nutrition
osmosis
platinum
protein
protoplasm
reproduction
retina
saprophyte
solvent
sperm
stalactite
stigma
stratus
telescope
Torricelli
vaporization
velocity
ventilation
Venus
watt-hour

Relation of General Science to Agricultural Instruction

Report of Committee of the American Association for the Advancement of Agricultural Teaching at Baltimore, Md., January 1, 1919.

Your committee has prepared a brief report based upon a study of the work in general science in typical high schools. For this purpose several hundred such schools were selected from all parts of the United States. No effort was made to choose the largest or the best, the only consideration being that their work typified the most progressive thinking of the state. Members of the committee personally visited and inspected the work in several hundred schools. This was supplemented by a further study from catalogs, outlines of courses, and by the questionnaire method.

In a special study conducted by the chairman complete data which in the opinion of the committee are fairly representative were secured from 58 schools and it is upon this data that the percentages found in this report are based. It is the confident opinion of your committee that the experience of representative institutions forms the best basis for judgment both as to the soundness of the present methods and the wisdom of our future policy.

At What Place in the Curriculum is General Science Introduced?

Ninety-three per-cent of the schools studied offer general science in the ninth grade and all but 7 per cent of this group confine the study to this grade. One-half of the remaining 7 per cent offer work in this subject in both the seventh and eighth grades and the other half in both the ninth and tenth grade. Thus it will be seen that this work is taught to four different grades, but is confined to the ninth grade in the large majority of schools.

4. *It would then appear that general science has become pretty firmly established as a ninth grade subject.* The ninth grade as used here indicates the first year of the high school or the corresponding year of the junior high school.

HOW MUCH TIME IS DEVOTED TO GENERAL SCIENCE?

The amount of time devoted to this instruction varies as follows: 34 per cent of the schools devote one semester to the subject; 58 per cent one year to it; 7 per cent two years and one school spreads the work over three years. In 80 per cent of all the above institutions, daily work is given throughout the entire period of instruction. In 35 per cent of these schools one or two hours per week of laboratory work is given. In 65 per cent of the schools, no laboratory work is undertaken.

It is also to be noted that the schools extending the work over two or three years are the ones who do not give daily instruction in this branch.

2. *Experience indicates a tendency toward daily recitations in general science throughout a period of one year.*

ARE PUPILS REQUIRED TO STUDY GENERAL SCIENCE?

In exactly 50 per cent of the schools the work is required of all students and in an additional 28 per cent it is required of all groups taking scientific courses. In but 22 per cent of the schools is general science a wholly "free elective" and judging from the size of the enrollment in the general science classes in the latter group of schools, it is a popular course and appears to be elected by the majority of students.

3. *The inevitable conclusion to be drawn from these facts is that general science is a subject pursued by the largest majority of the student body in those schools where the instruction is offered.*

HAS GENERAL SCIENCE COME TO STAY?

Our method of study necessarily forced us to secure data from those schools which had been giving the work for some time. Seventy per cent of the institutions furnishing information had offered the work for more than three years, forty per cent had offered the work from five to ten years and in two

of the schools instruction had been given for more than ten years. This condition taken in conjunction with the fact that the subject was required in the majority of institutions and "popular" in the remaining minority, leads to the conclusion that:

4. *General science has come to stay.*

WHAT IS THE CHARACTER OF THE SUBJECT MATTER?

There is still a tendency to teach general science as fragments of differentiated sciences. To get at this point, the question "what is the distribution of time in the general science course between biology, chemistry, physics, and geography" was asked.

To this question over 80 per cent of the schools indicate a definite distribution of time in their replies. The remaining number, however, say either that it is impossible to give an estimate of the proportion of time given to each branch or frankly state that no such division is made. It is only fair to conclude that the division given by some of those who make a distribution was probably due to their extreme conscientiousness in replying to the question, but their effort to do so indicates that they believe such a division is possible and proper to make, which your committee believes inadvisable.

If—as Caldwell and Eikenberry assume—pupils should be so instructed that they do not feel that they have had any of the differentiated sciences "but become much interested in the later study of these sciences" is the proper ideal, then

5. *The character of the subject matter now presented in these courses is their chief weakness.* This your committee believes to be true.

WHO TEACHES GENERAL SCIENCE?

In 15 per cent of the schools the teaching is done by graduates of agricultural colleges, in 65 per cent by teachers who have specialized in some science in their college course and in the remainder by persons of no special scientific preparation. In the case of the latter class, it is apparent that the teacher

has made or is presumed to have made special preparation for the teaching of these classes. In but one case in the entire group has special preparation been made for the teaching of general science as a subject important in itself.

6. *These facts indicate to your committee that the preparation of the teacher is a real source of weakness in general science instruction.*

If general science has come to stay in the ninth grade, and is to cover a period of at least one year, as a subject of general study, then we must prepare teachers who are able to teach it to this particular group of pupils for this specific length of time, or longer;

(a) As a means of understanding environment
(b) As a tool to be used in other school work
(c) And as a stimulus to further study of differentiated sciences.

ARE AGRICULTURAL COLLEGES CONCERNED IN THE PREPARATION OF THIS CLASS OF TEACHERS?

The interest of the student of agriculture in his environment is certainly no less than the interest of any other group of students. In no other group of students is the habit of environmental study more essential.

The student of agriculture *must* have some general science information as a tool to be used in his regular work. He *must* be a consistent student of his environment and to thoroughly understand the problems of agriculture he *must* be led to further intensive study of "differentiated" science. Thus from every point of view general science is as closely related to agricultural instruction as it is to any vocation or group of studies.

7. *Hence your teachers of agriculture should be thoroughly familiar with the plans and purposes of general science teaching, and the converse is also true.*

SHOULD AGRICULTURAL COLLEGES PREPARE TEACHERS OF GENERAL SCIENCE?

That specific preparation for teachers of this branch is necessary may be admitted as axiomatic. The proper place for giving such preparation under present conditions is largely a matter of expediency.

The possible institutions equipped for this work are, normal schools, teacher's colleges or teacher's training departments in universities—and colleges of agriculture. Of all these institutions the colleges of agriculture are the best equipped for this work. The normal schools lack both in intensity and breadth of scientific work and in material equipment. Teacher's colleges and training departments train for instruction in differentiated sciences with the weight of emphasis on professional work. University courses are frequently narrow and intensive and no adequate machinery exists in most of these institutions for correlation of the various sciences. On the other hand, the agricultural colleges base their courses upon a broad scientific training in all the differentiated sciences. Their students are already equipped with this necessary foundation for general science teaching and the application of the differentiated sciences to their agricultural work has led them to discover their mutual interdependence. Of all institutions, therefore, the agricultural colleges should be the best prepared to add courses of training for general science teachers to their regular work and are the most likely under present conditions to succeed with it.

In many of the smaller schools no separate teacher of general science can be employed. If the teacher of agriculture must teach something else this is the subject for which he is best prepared.

In the larger institutions, under the present plan, separate teachers are provided for each of the differentiated sciences. In either event the teacher of general science who has received his training in an agricultural college has the best chance for success.

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A Series of Unit Courses for Secondary Schools

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The power of the new, the novel, the unusual is felt in all activities of life. The novelty may be due to the originality of the idea, to the modification of an old idea, or to the simple dressing up of a former conception with a new name. That part of life which we find in our public schools is no less subject to such forces and at this time we find a rather original modification of an old idea dressed up in the same "project" demanding consideration. By some it is considered the panacea for all educational ills; by others it is looked upon as only one of many good methods of teaching. Some would rub the lamp and have the genii bring in the new in its complete form, relegating the old to the rubbish heap; others are glad to recognize its worth, but prefer to add the good of the new to what has been found good in the old.

There has been much discussion among Educators as to just what a "project" is and though many definitions have been submitted, there still seems to be no common agreement as to terms. It is not the purpose of this paper to attempt the definition of the term and for that reason the name "unit" has been chosen and will be used throughout this discussion. Thus whether the suggested units fall under the head of project, problem, topic, report, exercise, experiment, or what not, dependent upon the opinion of the reader, the value of the general plan will not depend upon definition.

The unit will be considered as something of educational value which the student earnestly wishes to do because he recognizes its worth and is so much interested in it that he goes ahead and does it. The value of such activity is practically universally recognized by those who have given thought to methods of teaching and learning. It is to those principals of secondary schools who realize both the small amount of teaching of this

type that is done and the need for it among our high school students that this plan is submitted.

The aims in view are twofold; the first being to provide for students an avenue through which they may carry out some continuous and unified line of work, in which they are interested, thus allowing the fullest educational development; the second being to provide demonstrations for the teachers of a new form of unified teaching, in which the student is actively learning rather than passively being taught. This latter aim is in reality secondary to the former for it is only in order that the teachers in turn may contribute again to the greater growth of the student.

TWO EXAMPLES

Lest it be thought that the plan be purely theoretical, it might be well to consider two specific cases in which elements of the general idea have proved highly successful. Similar experiences are no doubt common to many schools, but have been considered as entirely incidental and not of educational value. In a high school of about four hundred students three boys came to the science teacher and asked if there would be a possibility of constructing and operating a wireless outfit at the school building. It was suggested to them that they learn all they could about what would be required and the probable cost, and that they then take the matter to the principal of the high school. Some of the school time and much of the outside time of the boys for a period of several weeks was devoted to an exhaustive study of catalogues, text books, and scientific magazines and they were then able to submit plans for and the approximate cost of a suitable outfit. Through the principal they were enabled to secure the financial backing of the Board of Education for the sum of fifty dollars, which they had estimated would be the probable cost of installation. To show in detail the successive steps taken and the difficulties encountered would carry us beyond the limits of this paper. It is sufficient to say that the entire outfit was purchased, installed, and operated by these three boys with the help at times of several others who willingly volunteered. The only other help was in

the form of a few suggestions from the science instructor, the suggestions being chiefly as to sources of information. Messages were received from Arlington, Va., the Lake boats and occasionally Gulf Steamers within a radius of seven hundred to eight hundred miles though the sending radius was only about five miles. Soon not only the school pupils but the people of the city were interested and several demonstrations were given. True much time was taken in doing this; but no one will doubt the value of the returns not only in science, but in reading, mathematics, business methods, fire insurance questions, and mechanical construction as well.

In the same school four of the girls of the Commercial Department had attained the required speed in shorthand and typewriting. In order that they might get some experience in office practice, they were allowed one credit for spending two or more hours each day in the offices of the principal and superintendent. There they took business letters from dictation and later composed less important letters themselves. They were made acquainted with filing systems, making of reports, collecting data, keeping records, and other items of office business. Throughout, the ideal of error-proof work was held and the letters which came to the office were inspected and judged. These girls were also allowed to go to certain business firms and offices for short periods to write letters for them. These same girls were followed up the next year and in each case they were more successful than those who had not this training. A part of the success is probably due to the fact that those with greater native ability completed their speed tests earlier, but that the office practice had been of great help was questioned by no one.

GENERAL PLAN

These two specific examples have been cited to give a basis on which to draw a general plan for a series of unit courses. There are of course a few very fundamental needs upon which the success of this policy, just as the success of any school, depends.

(1) A sympathetic, well trained teacher of broad experience is the first requisite. A wide fund of information would

be valuable, but even more emphasis should be placed on a spontaneous enthusiasm, the ability to inspire, and a knowledge of how to get materials through magazines, bibliographies, and other sources. Should the principal have such a teacher, well and good, if not, it is his task to select the best available and through his own enthusiasm convert him to the plan. Above all things avoid the teacher who has ossified in the profession and is wedded to a set of fixed ideas.

(2) The rest of the teaching corps should be made thoroughly acquainted with the plan and should be willing to co-operate in every way in conferences, references, and helps to students whose unit lies chiefly in their field of interest.

(3) A library with encyclopedia, reference books, and magazines should be in the school or such materials should be available near the school, the former of course being preferable. Laboratories, land near the school, and other tools and facilities should be available depending upon the community and the units selected.

Having more or less fully met these requirements, the course may be offered for students to elect with the understanding that they mean business and are willing to spend two or more hours per school day on their unit while in the group. The class will have a regular meeting time, but the conduct of the period will depend entirely upon the progress of the various units. The only time at which all would be giving attention to the same thing would be when a unit had been carried to such a point that a demonstration or report would be of value to all. The meetings of the group should be conducted more under a plan similar to that called Supervised Study, though that term might be misleading. In general it might be a time for (1) reference reading and note taking, (2) questions to the teacher in charge to clear up major difficulties, (3) reports of progress, (4) arrangement for conferences with the teacher in charge of the department in which the unit seems naturally to fall, (this does not preclude units which lie in several fields or consulting other instructors), (5) making of bibliographies and securing other references, (6) as suggested before, reports and demonstrations, when the unit is carried as far as desirable, on what the student has done and learned, and (7) judging the value of the unit and importance to the student and to others.

SOME SUGGESTED UNITS

Here it might be well to state that these units are on the Beta side of our Program, nevertheless it is dependent to a great extent upon the Alpha subjects and throughout, the value of the Alpha in the success of the unit might be tactfully indicated. Just as the course itself is elective, so should the choice of the unit be left to the individual student. It is highly desirable to have a list of suggested units which would serve as much as a guide to the selection of others as a group from which to choose. It has been considered advisable to include such a list, all not being adapted to any single school, but being broad enough that the teacher in charge may select and supplement according to local conditions.

1. Construction and operation of a Wireless outfit.
2. Office practice for Commercial students. (as suggested above)
3. Plant acre of corn or have home garden. Use agriculture texts, government bulletins, etc.
4. Make classification of high school graduates and their occupations. Opportunities in the community. Vocational survey.
5. Correspondent for local papers. Have charge of a local current event and editorial bulletin board. Editor of high school paper.
6. Run a series of butter fat tests on the cows of the community by the Babcock method. Bulletins and Journals.
7. Make set of furniture in connection with Manual Training Department.
8. Read a comprehensive list of books.
9. Study the play of the world. Great men and their games.
10. Make complete clothing equipment in connection with Home Economics Department.
11. A study of the Immigration problem.
12. League of Nations. Compare and contrast with other treaties.

13. Study of city or rural water supply.
14. Money of all Nations.
    Things which stand for money.
    Bonds and finance.
15. Visit to power plant. Home lighting and power.
16. A study of local Industries.
17. Sub-marine in war and peace.
18. Aerial Navigation.
    Historical and scientific.

SOME OBJECTIONS AND ADVANTAGES

Before a school principal has read this far no doubt some of these objections have come to his mind:

"How about college entrance requirements? It will take too much of the teachers time. Pupils will neglect other subjects. We do not have the equipment." There is no doubt as to the validity of such questions, but allow a few suggestions with some additional advantages. One of the leading Universities of the United States has arranged for a psychological entrance test which is based upon ability to cope with the various elements of situations rather than upon knowledge alone. Other colleges are requiring fewer credits for entrance. At present of course it is necessary to limit the credits allowed under the foregoing plan. The teacher's role is to suggest and give help only in difficulties, which will not cause undue demands on his time. True, pupils might to a degree neglect other studies, but some neglect them now for other things of far less value. Let the substitution be for the other things and the loss will be gain. The lack of equipment is truly a handicap, but such as needed might be improvised or better still purchased as equipment for such units will often be of the greatest educational value for the school as a whole. We have still the facts to face that such a plan will provide for purposeful activity along the line of the real interests of the students. Individual differences may be cared for. The pupil is given an opportunity to find himself. The value of related Alpha subjects is seen. The boy or girl who has completely lost interest in formal school work may be reached. And last but not least an avenue is found

whereby the principal may illustrate to teachers of the "old school" how results may be procured by other methods. The inefficiency of oral suggestion alone in such supervision is recognized. A more effective method is to use demonstrations as is outlined above.

A constructive program has been suggested to introduce what by some is called the "project." By whatever we wish to call it, this method of teaching or this unit of work has a place in our schools, and the plan is submitted to those principals of secondary schools who desire to do pioneer work in a worth while field.

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Studies of the Masters

III. Charles Robert Darwin

By John F. Woodhull

On February 12th, 1809, there were born two of the world's greatest men; Charles Robert Darwin in England, and Abraham Lincoln in the United States. These two men are associated together in one's mind not merely because they chanced to have the same birthday, but because they had very similar traits of character. This paper is an attempt to give a composite photograph of Charles Darwin as derived from his numerous biographies.

Darwin's formal education was acquired at Dr. Butler's school; at Edinburgh University; and at Cambridge University. Concerning this education we have his testimony as follows: "Nothing could have been worse for the development of my mind than Dr. Butler's school. As a means of education to me it was simply a blank." "The instruction at Edinburgh was intolerably dull. I attended ——'s lectures on geology and zoology, but they were incredibly dull. The sole effect they produced on me was the determination never as long as I lived to read a book on geology, or in any way to study the science." "During the three years which I spent at Cambridge my time was wasted as far as the academical studies were concerned." "I was so sickened by lectures on geology in Edinburgh that I did not attend the eloquent and interesting public lectures of Sedgwick."

All the while that Darwin was being bored by the instruction of the schools he was an ardent and diligent student of science outside of school. He made collections of all sorts of specimens for his museum and studied chemistry, oftentimes till late at night in his own improvised laboratory. "This" he said, "was the best part of my education." "I was (however) publicly rebuked by Dr. Butler for thus 'wasting my time on such useless subjects'."

This extra-academic zeal for science he continued to display while at both Edinburgh and Cambridge. He made the ac-

quaintance of many naturalists, and on numerous occasions displayed both his rare gifts at original research and some of the results. During these years he also read much and widely outside of the regular academic courses. He took delight in Shakespeare, Milton, Wordsworth, Coleridge, Scott, Humboldt, Herschel, Byron, Gray, Shelly, Gilbert White, etc. He gave considerable attention to music and art; found much delight in poetry and fiction; was fond of sports; was counted a most agreeable companion; but his special delight was in the outdoor school of nature.

A college friend testifies that in his undergraduate days "he was the most genial, warm-hearted, generous and affectionate of friends; that his sympathies were with all that was good and true; and that he had a cordial hatred for everything false, or vile, or cruel, or mean, or dishonorable."

He worked by the "project method" assimilating that which commended itself to his mind, and rejecting that which found no appropriate soil in him. During these undergraduate years he laid tribute on all outdoors, on libraries, on public museums, and on living naturalists for the education denied him in the "halls of learning." He took the B. A. degree "by the easiest road and obtained it with the minimum of effort" in the year 1831, having pursued those courses which Cambridge prescribed for the manufacture of clergymen.

The man who had thus far made the deepest impression upon Darwin was Professor Henslow of Cambridge "A man who knew every branch of science." With him Darwin took almost daily walks and talks. Henslow had discovered Darwin and devined something of his future greatness. It was through Professor Henslow that Darwin when only twenty-two years of age was appointed naturalist to H. M. S. Beagle for a five year trip around the world. Of this trip Darwin said "I have always felt that I owe to this voyage on the Beagle the first real training or education of my mind."

He took with him on that trip Lyell's Principles of Geology which had just issued from the press. This he studied diligently and by means of it learned to read the book of nature itself. He always after that looked upon Lyell as his great teacher. To him he dedicated the Journal of his trip, and inscribed upon the title page these words: "the chief part of whatever

scientific merit this journal and my other works may possess has been derived from studying the well-known and admirable 'Principles of Geology'."

Darwin was not at this time, nor did he ever become, a specialist. He collected vast quantities of material in every field of natural science. He observed most widely and generalized most broadly. On this voyage around the world, his projects led him into the fields of biology, geology, and all the other sciences. He made researches in ethnology, oceanic phenomena, the height of the snow line, the climate of the Antartic Islands, the formation of icebergs, the transport of boulders, the habits and manners engendered by slavery. These and many other lines aroused his interest and called forth his study to an equal degree. "Nowhere do we get the faintest trace of narrow specialism. He had taken the whole world of science for his province—Darwin's spirit ranged freely over the whole illimitable field of nature—No one can have a firm grasp of any science if he confines himself to it alone. The philosophy of every department depends upon its connection with other departments."

After the close of his voyage around the world (1836), he published his Journal of the trip which had a very large sale from the first and is still having a good sale more than three-quarters of a century after its publication. It has been called the best of all Natural History journals which have ever been published. One of the first books which he published after the Journal was "Coral Reefs" (1842). Of this Sir Archibald Geikie says "no more admirable example of scientific method was ever given to the world."

In 1842 he built a house in the quiet village of Down, in Kent, twenty miles southeast of London, and four miles from a railroad station or a telegraph office. Here amid his ample gardens he and Mrs. Darwin and their five boys spent a most ideal life. During the next forty years he did a prodigious amount of work although suffering continually from ill health. He had a comfortable fortune and was thus relieved from the anxiety of earning a living. Fortunately also every member of his family was considerate and helpful. His recreation consisted in walks, reading novels and playing games, in all of which pastimes Mrs. Darwin and the children participated. He

brought forth nearly every year either a new book or a revision of one of his books. He published twenty-three books and fourteen revisions beside eighty-one important papers, all of which were master pieces of research.

His most famous work the "Origin of Species" published in 1859 went through six editions in his life time. The first editon being completely sold out on the day of its publication. It has been translated into French, German, Italian, Russian, Spanish, Dutch, Swedish, Hungarian, Japanese and Hindustani. More than twenty years ago the sales in England had amounted to forty thousand copies. It was also very largely sold in all other civilized countries. It is one of the most valued of all the English classics.

His second book in importance was the "Descent of Man" published in 1871, which through three editions in the first twelve years (17,000 copies).

His last book "The Formation of Vegetable Mould through the Action of Worms" was published in 1881. A second edition was called for in the same year, and a third edition was issued in 1882. 8,500 copies were sold in three years. This book is the record of a project which he had carried on for forty years. His books were generally the results of from ten to forty years of patient research and reflection.

Some of his other best known projects, all of which have been preserved for us in his books, are: Volcanic Islands; Geology of South America; Orchids; Climbing Plants; Animals and Plants under Domestication; Expression of the Emotions, 5,227 copies of which were sold on the day of its publication; Insectivorous Plants; Cross and Self-Fertilization; Different Forms of Flowers on Plants of the Same Species; Movements and Habits of Climbing Plants. The phenomenal sale of Darwin's books is due to two causes; first, he dealt with subjects of universal interest and second, he wrote so that the mass of mankind could understand him. It is safe to say that if he had been a specialist he could not have written a single one of his works nor could he have performed a single one of his researches.

He enjoyed the acquaintance of a host of famous men such as: Humboldt, Sidney Smith, Carlyle, Macauley, Scott, Spencer, Haeckel, Fiske, Youmans, Herschel, Tyndall, Galton, Ray

Lankester, Geikie, Wallaston, Lubbock, Wallace, Asa Gray, Henslow, Lyell, Hooker, and Huxley. The last four were his most intimate friends and constant supporters.

Huxley said "The most potent instrument for the extension of the realm of natural knowledge which has come into men's hands, sonce the publication of Newton's Principia, is Darwin's 'Origin of Species'. His name stands alongside of those of Isaac Newton and Michael Faraday as a searcher after truth and interpreter of nature."

In 1884 David Starr Jordan wrote "Let me speak of certain traits of this work, the 'Origin of Species', which give it a position almost alone among books of science. There is in it no statement of fact of any importance which, during the twenty-five years since it was first published, has been shown to be false. In its theoretical part there is no argument which has been shown to be unfair or fallacious—He has been the faithful mirror of nature."

Asa Gray the famous American botanist wrote Darwin that he never learned so much from any book as from the "Origin of Species."

Hooker testified that his long and intimate friendship with Darwin was the great event of his scientific career.

The "Origin of Species" effected a revolution in every mode of thought and feeling. But the modest, singleminded, and unassuming author continued to work unmoved among his pigeons and orchids.

"He revolutionized not merely half a dozen sciences, but the whole current of thinking men's mental life."

J. W. Powell of the Smithsonian Institution said, "Darwin has demonstrated the laws of biologic evolution in a manner so masterly that there lives not in the world a working biologist who has not accepted his great conclusions."

"Before Darwin's time philosophers talked about deductive methods and inductive methods. But he has taught us that both are fruitless. Deductive and inductive methods have been superseded by the method of working hypotheses. Darwin, more than any other man, has taught the use of working hypotheses."

"Darwin judged that the truth must ultimately assert itself. He skilfully and powerfully marshalled the facts so that the

conclusion followed without being stated."

"Newton and Darwin are the two great lights of Science."

The central idea of the "Origin of Species" is this: By careful and long continued selection breeders have been able to develop at pleasure the fleet race horse or the powerful draught horse from a common stock. Gardeners likewise have been able to develop by selection, plants having such characteristics of fruit or flower as they may choose. Now what man has learned to do in this regard by repeated *selection* nature has always done and is all the while doing by a process of *natural selection.* There is a tendency to variation in animals and plants. Not all of a species of animals for example are alike in color. Those which have a protective coloring are more likely to escape their enemies and reproduce their kind and thus continue their existence while others of the species are killed off. Again, by variation some seeds of an individual plant have hairs while others have not. The winds waft those seeds which have appendages out beyond the shadow of the parent into the open fields beyond, where they live and reproduce, while those which had no hairs fall under the parent stock and are choked. Thus out of a freak variety there has developed on certain seeds the fixed characteristics of hairs.

Certain conditions in nature produce variations in plants and animals. These changes have been going on for unknown ages and all the diverse forms of today are the result of this process. This is the process called "natural selection" or "survival of the fittest." The strata in the crust of the earth have fossil forms embedded in them. The simpler forms are lower down, the more elaborate forms are higher up. The story of nature's book is that by natural selection the more complex forms have been evolved out of the simpler ones.

"The revelation of science is this: Every generation in life is a step in progress to a higher and fuller life; science has discovered hope." "If a monkey may become a man what may not a man become?" Man was not first civilized and afterward degenerate, "the highest form of religion, the grand idea of God hating sin and loving righteousness, was unknown during primeval times."

The closing sentence of the "Origin of Species" contains these words "There is grandeur in this view of life—from so

simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved."

Of course he met with opposition. He was "a man who was perhaps more widely attacked and more grossly misrepresented than any other" but says Powell "In Darwin's writings I find no word of reproach. Denunciation and ridicule greater than any other man has endured never kindled a spark of hatred in his breast. Wrapped in the mantle of his philosophy he received no wounds, but lived with and loved mankind."

Darwin himself said "whenever I have been contemptuously criticised it has been my greatest comfort to say hundreds of times to myself 'I have worked as hard and as well as I could, and no man can do more than this'."

"Darwin did not invent theory. He merely observed and pointed out facts which have brought all men who honestly attend, to comprehend and believe certain theories."

"The publication in 1859 of the "Origin of Species" made a crisis and a turning point in the history of mankind."

"The great biological revolution, which rightly sums itself up in the name of Darwin, reduced man to his true position. It unseated him from his imaginary throne in the center of the cosmos, teaching him at once a lesson of humility and a lesson of aspiration."

"In Charles Darwin an intellect which had no superior was joined to a character even nobler than the intellect."

"He never really knew his own greatness. He was a man of singular simplicity and largeness of heart, charming candor, delightful unostentatiousness, kindliness of disposition, width of sympathy, ready generosity, beloved by all." "Darwin was reverential and religious in the truest sense and in the highest degree."

He believed in a God and said "Nature's productions plainly bear the stamp of far higher workmanship than man's." He was reticent on these matters and "felt strongly that a man's religion is an essentially private matter, and one concerning himself alone." He believed in the immortality of the soul. At the close of his life he recognized the approach of death and said a few hours before the end "I am not the least afraid to die."

Darwin who has been the most abused of all men has also been the most highly honored. He received seven or eight degrees, half a dozen medals, honorary memberships in more than seventy scientific societies from more than twenty different countries. His books were more widely read than any other scientific books that have ever been published. When he died (1882) the only suitable place for burial (by common consent) was thought to be by the side of Sir Isaac Newton in Westminster Abbey. Among the pall bearers were W. Spotteswoode, President of the Royal Society; James Russell Lowell, American Minister; Sir Joseph Hooker; Alfred Russell Wallace, Sir John Lubbock, T. H. Huxley and Cannon Farrar.

The Bishop of Carlisle, preaching in the Abbey on the following Sunday said that Darwin had produced a greater change in the current of thought than any other man. The London Times said (1882) "The Abbey has its orators and ministers who have convinced senates and swayed nations. Not one of them all has wielded a power over men and their intelligences more complete than that which for the last twenty-three years has emanated from a simple country house in Kent."

"Ideas which a quarter of a century ago were regarded with dread are now accepted without a pang largely due to the fact that the leading exponent of these ideas was the least arrogant of men."

David Starr Jordan tells of a visit to Down, where Darwin's home was "I talked with the villagers who had been his neighbors all their lives and to whom he was not the world-renowned naturalist, but the good gray man whom everybody knew and loved. I learned some things which the books do not tell us of his simple, kindly ways, his warm friendships, and his quiet but wide reaching charities. I have from this a clearer picture of Darwin as he really was. His love for his wife and children, his love for birds and flowers and trees, his love for simplicity and truth—all these stand as the clear background before which rises the noblest work in science. His was a gentle, patient, and reverent spirit, and by his life not only science, but our conception of Christianity, has been advanced and ennobled."

Bibliography of the Project Method

Rose E. Herrold, New York, N. Y.

Whatever value this bibliography may have to those who use it will depend largely on their bearing in mind that it is not a finished product, but a somewhat limited summary of the beginnings of a movement in education. On every hand articles are appearing which analyze, outline and attempt to define this term, and text-books which make this a basis of their content are already in the field.

It is attempted to include in this list, with a necessarily limited summary, the current literature and books bearing on this subject as it is related to science up to May, 1919. It is doubtless true that some very important articles have been omitted, but any such oversight is unintentional and all corrections and additional references will be welcomed.

Bulletins gotten out by the various agricultural colleges and those of the U. S. Department of Agriculture and the U. S. Bureau of Education have not been included, and likewise one of the richest sources for obtaining an insight to the Project Method, i. e., the biographies and monographs of the masters of research, has been omitted. These both are very important sources and should not be neglected, but they are not within the scope of this paper.

Abbott, Lyman,—New Education: Making Farmers.
Outlook 116: 473-5 Jl 25 '17.

The author gives an interesting account of an automobile trip through the state of Massachusetts. Some agricultural schools were visited and several interesting projects are described.

Ashley, M. L.,—The Nature of Problems.
Chicago Schools Journal 1: 7-9 Nov.-Dec. '18.

A general discussion on the nature of problems and their educational significance.

Branom, M. E.,—Project-Problem in the Teaching of Geography.
J. Geog. 16: 333-8 My. '18.

The article discusses the Project-Problem and how it should be secured; outlines the advantages of the method and some

difficulties and dangers arising from it. Several illustrations of the Project-Problem are given and the four interlocking steps involved in its development are also briefly outlined.

Briggs. Thomas H.,—General Science in Secondary Schools.
T. C. Record 17: 19-30 '16.

A comprehensive discussion on the science situation in general. It analyzes very briefly the logical and psychological methods of presenting the sciences and shows that General Science was first suggested as a means of merging these two methods. Four functions which a science course should have are outlined, and following these is a general discussion of some of the various procedures necessary for the successful working out of these four functions.

Charters, W. W.,—Projects in Home Economics Teaching.
J. of Home Economics Teaching 10: 114-19 Mr., '18.

"In this paper the project is considered to be an act carried to completion in the natural setting and involving the solution of a relative complex problem." It suggests that the project be used, first as an approach to all parts of the subject, and then that a systematized study of the whole field follow as an extended summary. The article is interesting and definite in the stand taken.

Clute, W. N.,—Project Teaching, Some Objections to.
Gen. Sci. Quar. 2: 379-80 Mr., '18

The title alone is sufficiently suggestive.

Dennis, L. H.,—Home Projects in Secondary Agriculture.
N. E. A. 1916, pp 622-6.

A profitable discussion differentiating between the agricultural exercise and the agricultural project, and suggests supervision of home projects during summer months by paid teachers and a close co-operation between home projects, club work and the Bureau of Agriculture.

Dewey, John,—Democracy and Education.
The MacMillan Co., N. Y., 1916.

This book does not bear directly on the Project Method, but the trend of thought is in that direction. Chapters 8 and 17 are worthy of special mention.

Dewey, John,—Educational Situation. Part I.
University of Chicago Press 1904.

Profitable reading.

Dewey, John,—How We Think.
D. C. Heath & Co., 1910.

"This book represents the conviction that the natural and unspoiled attitude of childhood marked by ardent curiosity, fertile imagination and love of experimental inquiry, is near, very near to the scentific attitude of the mind"—Chapters 6 and 7 are especially good.

Dewey, John,—Method in Science Teaching.
J. Nat. Ed. Assn. 1:725-30.
Gen. Sci. Quar. 1:3-9

Although the term project is not mentioned, the Project Method may well be the outcome of this discussion.

Giese. W.,—Agriculture correlated with Manual Training.
Ind. Arts Mag. 6:477-9 Dec.: '17.

The article outlines a project which had for its twofold purpose, first to develop some plans of correlation between agriculture and manual training work, and, second, to give some practical experience in building construction.

Heald, F. E.,—The Project in Agricultural Education.
Gen. Sci. Quar. 1:166-169.

Herein are given definitions differentiating between home project, club project, project prepared by scientific investigators, and extension project. It also compiles in brief form the requirements common to projects applied to instruction in agriculture, and briefly outlines such a project.

Higgins, L. D.,—Cutting off a Limb—a Project.
T. C. Record 17: 38-9 Ja. '16.

An interesting article.

Hofe, Geo. D. von,—Development of a Project.
T. C. Record 17: 240-246 May '16.

The author would replace the lesson plan by a project, substitute problems which are met in life for the older science alpha-bets, and return the text-book to its office of reference handbook. Suggestions for developing projects by the use of periodical literature, museums and slides are given.

Hofe, Geo. D. von,—General Science is Project Science.
Sch. Sci. and Math. 15: 751-757 Dec. '15.

A profitable article justifying the teaching of General Science by the project method.

Hofe, Geo. D. von,—Giving the Project Method a Trial.
Sch. Sci. and Math. 16: 763-7 Dec. '16.

An interesting account of how the project method is put into use in the Horace Mann school without the use of the crystallized general science found in text-books.

Kilpatrick, W. H.—Theories Underlying the Experiment.
T. C. Record 20: 99-106 Mar. '19.

This article aims to set forth the underlying principles of, and to describe certain experimentations in primary education, that were begun in the Horace Mann school in 1916. It is presented as an informal address to the parent of the children attending the experimental classes.

Kilpatrick, W. H.,—The Project Method.
T. C. Record 19:319-335 Sept. '18.

"The purpose of this article is to attempt to clarify the concept underlying the term, as much as it is to defend the claim of the concept to a place in our educational thinking." The unifying idea brought out is the concept of a whole-hearted, purposeful activity proceeding in a social environment. This purposeful activity is based on the laws of learning.

Kilpatrick, W. H.,—Project Teaching.
Gen. Sci. Quar. 1: 67-72.

A splendid article showing that facts, in particular scientific facts, are first psychologically perceived and then logically analyzed according to the intellectual attainment of the individual. It therefore protests against the predigested knowledge, the product of the adult mind, being thrust upon the immature minds of children with the vain hope that they will profit by it. It advocates the project method as the "psychological" method of teaching. It is rich in illustrations and concludes with a test for success in science teaching.

Lane, C. H.,—Aims and Methods of Project Work in Secondary Agriculture.
Sch. Sci. and Math. 17: 805-10 D. '17.

The material in this article is based on the project work in Secondary Agriculture as worked out in Michigan and Massachusetts. It also outlines what the author considers seven essentials of a successful project.

Lott, D. W.,—Project, A Twenty Minute.
Gen. Sci. Quar. 1:122-126 Jan. '17.

An interesting article; well worth reading.

Lull, Herbt. G.,—Project—Problem Instruction.
Sch. and Home Ed. 38: 79-83 D. '18.

A very profitable article. Tells how a project may arise and some things to be avoided in Project-Problem teaching. Discusses the following topics and presents score cards which aim to measure efficiency of teacher and pupil as to: (1) Pupil's Activity in the Recitation; (2) Pupil's activity in the Supervised Study Period; (3) Teacher's Activity in the Recitation; (4) Teacher's Activity in the Supervised Study Period.

Lunt, J. R.,—An Illuminating Gas Project.
Gen. Sci. Quar. 1:213-215 My. '17.

A "Logically" arranged project.

Mann, C. R.,—Project Teaching.
Gen. Sci. Quar. 1: 13-14 Nov. '16.

A short discussion suggesting the introduction of General Science Courses conducted by the project method, into colleges and universities. It also gives Dewey's formula for science teaching.

Massachusetts Committee,—Psychological Factors affecting Method.
Material and organization.
Gen. Sci. Quar. 1: 93-101 Jan. '17
1: 180-188 Mar. '17
1: 228-230 May '17

This report furnishes some good material which is suggestive for working out a course in science on the project basis.

Meister, M.—"Guiding and Aiding the Pupil in His Project."
Gen. Sci. Quar. 3: 209-215 May '19.

The content of this article is based on several years' successful project teaching at the Horace Mann and Speyers schools. It furnishes in outline form some good material and methods and is therefore one of the most helpful articles written on this subject.

Meister, M.—Science Work in the Speyers School.
Gen. Sci. Quar. 2: 429-445 May '18.

From the practical standpoint this is one of the best articles written on this method. It discusses in a most interesting manner the successful use of the project method and the work of the Speyer's Science Club. The work as outlined could well be duplicated in other schools.

Meister, M.,—The Method of the Scientists.
M. A. Thesis '17, Columbia University.
Also Sch. Sci. and Math. 18: 735-740, Nov. '18.
An interesting and convincing article. It analyzes the method of a scientist at work and definitely states the various steps he would naturally use. Forecasts a change in the method of teaching science.

Moore, J. C.—Projects.
Gen. Sci. Quar. 1: 14-16 Nov. '16.
A short discussion on how the project may be selected and its approach by pupil and teacher. Also briefly outlines the project—"Hard Water."

Moore, J. C.,—Project Science, Progressive.
Sch. Sci. and Math. 16: 686-90 N, '16.
This article analyzes to some extent the high school situation in regard to science. It offers destructive criticism on the usual content of Physics tests and briefly discusses the project, dividing it into: (1) interest; (2) activity; (3) search; (4) organization.

Randall, J. A.,—Project Teaching.
N. E. A. Report 1915: 1009-12.
"The chief object of this paper is to prepare a technical definition for the word "project" and to expand the idea for which the word stands." Suggests the use of the term "problem exercise."

Smith, Edith L.—A Project of Everyday Machines.
Gen. Sci. Quar. 3: 31-33 Nov. '19.
A live account of some interesting work.

Snedden, David—The Project as a Teaching Unit.
Sch. and Soc. 4: 419-423
The author shows why the curriculum has been divided into teaching units, viz.,—the question and answer, the lesson, the topic and the project. Gives the four primary characteristics of a project and lists alternatives of the project, in a limited sense, in manual training and practical arts, and its application as a teaching unit in general science. Suggests dividing projects into the execution project (home), execution project (home and school) and the observation and report project.

Sones, W. W. D.—Story of My Suit: An Outline Project.
Gen. Sci. Quar. 2: 293-296 Nov. '17.
A suggestive outline of a project that may consume a week or a month.

Stevenson, J. A.,—Project in Science Teaching.
Sch. Sci. and Math. 19: 50-63.
Gen. Sci. Quar. 3: 195-209.

A comprehensive discussion. Determines the four elements in a type of teaching which constitutes the project. The commonly used concepts are examined and found inadequate to meet the situation and as a result the concept project is proposed. The author also defines this concept and gives a discussion of the four factors involved in the definition. He shows the need of the concept project for a certain type of teaching and gives the definitions suggested by the leading advocates of this method among which are those of Woodhull, Meister, and Mann.

Stevenson, J. A.,—The Project and the Curriculum.
Sch. and Home Ed. 38: 146-50.

The author divides the principle methods of making a curriculum into the logical and project method and defines these two methods. Selects thirty-two processes as the basis of a curriculum in Woodworking and shows how these thirty-two processes can better be taught as parts of eight selected projects. Outlines a project by C. W. Stone which illustrates what Dewey calls "facts not torn away from their original place and experience." He gives two plans for the organization of subject matter in the curriculum, i. e., the method by independent subjects, and a scheme of major and minor subjects, the latter being the project method. He concludes the discussion by a consideration of the project as a basis for curriculum organization.

Stone, C. H.,—The Making of a Match,—a Project.
Gen. Sci. Quar. 3: 89-90 Jan. '19.

Interesting; gives specific directions for making a match.

Stone, C. H.,—Optional Project Work in Chemistry.
Gen. Sci. Quar. 1: 233-236 My '17.

An article which shows how the English High School in Boston provides project work for the exceptionally bright pupils.

Stratton, M. N.,—Factory Plan Project: Children's Porch Swing.
Ind. Arts Mag. 8: 11-13 Jan. '18.

A suggestive article for correlating arithmetic, language and geography with projects in practical arts.

Taylor, W. S.,—Project method in Teacher-training Course.
School and Society 8: 489-90 O. '18.

A very good discussion. It suggests several projects that could be taken up in such a course; outlines the advantages of the project method and concludes with the "acid test" for good teaching according to Kilpatrick and Dewey.

Williams, R. H.,—An Introductory Fire Project.
Gen. Sci. Quar. 1: 216-221, Mar. '17.

The author aims to show how the first lesson on "fire" could be presented to a class. The plan of this lesson is given in detail.

Workman, Linwood L.,—A Project in Ventilation.
Gen. Sci. Quar. 3: 33-34 Nov., '19.

A very short but convincing and profitable project.

Woodhull, J. F.,—Aims and Methods of Science Teaching.
Gen. Sci. Quar. 2: 249-250 Nov. '17.

The author does not differentiate between the project and problem, but shows the superiority of these over the logical text book method. States the present need for a large collection of sample projects which might be used in a given community.

Woodhull, J. F.,—Project Method in the Teaching of Science.
Sch. and Soc. 8: 41-4 July '18.

Explains the nature of a project, relegates the text book to its position as a reference book and substitutes books which present science as living projects. A very convincing article.

Woodhull, J. F.,—Projects in Science.
T. C. Record 17: 31-39 Jan. '16.*

A suggestive article giving in brief an account of how five different professors pursued as many different projects. Three projects are given in detail, viz: Drowning Trees, The Mill Pond, and Cutting Off a Limb.

Woodhull, J. F.,—The Project of a Frozen Water Pipe.
Gen. Sci. Quar. 3: 107-111 Jan. '19.

An account of an interesting and instructive home project which extended over a period of a little more than two months.

Woodhull, J. F.,—Science Teaching by Projects.
Sch. Sci. and Math. 15: 225-232 Mar. '15*

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*These articles are also found in Prof. Woodhull's "Teaching of Science".

A convincing article favoring the "Psychological" rather than the "logical" method of presenting science and the conclusion reached is that this method of presentation is best worked out by the project method,—the method of the masters of research.

Woodhull, J. F.,—The Teaching of Science.
The Macmillan Co. N. Y. 1918.

"This is a collection of addresses and papers bearing upon the general theme, science teaching, and in a measure constitutes the history of a movement in education." The book as a whole is exceedingly interesting. Chapters 13, 14, 15, 17 and 18 give a splendid insight to the project Method.

Van Buskirk and Smith,—Science of Everyday Life.
Houghton Mifflin Co., N. Y. 1918.

A general science text which aims to use the Project Method. It is divided into five major topics: Air, Water, Food, Protection and the Work of the World and under each of these is given a series of projects, leading to general principles.

Aims and Purposes of General Science [1]

BERTHA M. CLARK, Head of Science Dept., William Penn High School, Phila., Pa.

Uncle Sam created a student army training corps. General science should create a student science training corps. With the signing of the armistice by the belligerents, the need of Uncle Sam's training corps ceased. But since no armistice will ever be declared between health and disease, heat and cold, hunger and satiety, progress and retrogression, the need for a student science training corps will probably never cease. The important fact about the student science training corps is not that it is made up of students, nor that it relates to science, but that it is so organized that each student *serves* while he trains. What is meant by this will appear later.

The aim of general science as expressed in the prefaces of different text books by 13 different authors is roughly "*To introduce boys and girls to a scientific study of their environment,*"

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[1] Delivered at Educational Congress held in New York State Ed. Building, Albany, N. Y., May 21, 1919.

"*To develop a usable fund of knowledge about common things,*" or "*To teach a pupil what he needs and what he can use.*" These statements show that general science, so far at least, has centered upon the individual, the environment being considered mainly because of its effect upon him. He studies the important elements in environment, such as air, water, food and he learns how to utilize and become master of them. So far, so good.

The pupil must be acquainted with the elements in his environment and must know how to use them to advantage. But to *whose* advantage? To his own mainly? Or to the advantage and improvement of the environment? Is the *individual* in the environment or the *environment* itself the central figure of general science? If the *individual* is the central theme and the environment merely relates to *him* are we not inculcating in him lessons in scientific efficiency instead of lessons in scientific service?

Environment is the sum of all the external conditions that limit or direct the activities of an individual or group. Each pupil, therefore, is an element in his neighbors' environment, and in his community environment just as truly as is air, or water. Is there any reason why he should think that scientific efficiency consists in getting the most possible from an environment rather than in giving the most possible to it? In addition, *he* as typical of the human race, is a thinking, reasoning creature, and is therefore the *only* element which can consciously scientifically improve that environment. The aim of general science should not be to teach a pupil what he needs and what he can use from his environment, but what he can daily give to his surroundings and how he can immediately improve them. Why does the pupil think he is taught the scientific firing of his furnace? Primarily to get greater comfort in his home? To get the largest number of calories from the coal bought? To secure the maximum amount of heat with the least expenditure of his attention to the fire? If so, general science is based primarily on efficiency and will meet its doom sooner or later just as the German Military Machine with all its efficiency met its doom. Or does scientific heating become a duty whereby the student can pass on the race inheritance of coal as little diminished by him as is consistent with human evolution?

Do lessons in soil fertility leave as their main impression maximum return in crops, reduced cost of living, fewer hours of hard work? Or do they leave an indelible lesson that a gardener, as a member of the human family, which alone of all the varying elements in an environment can scientifically improve it, must have some leisure to live with the ideas and ideals which precede rational attempts at improvement of the race? *Is it labor saving devices or service creating devices that are valuable?* Does the pupil feel from his first lesson in general science that it is the race and not the individual that is the focus of scientific thought? That this idea can be presented to advantage is shown in the success of war gardens. Very few pupils planted seeds in order to help themselves principally; they planted seeds and sweated over the hoeing and weeding in the long hot days of summer for the sake of the boys in the trenches, for the hungry children in Italy and France and Belgium and for the wounded enemy prisoners. It is not often that so striking an incentive to commonplace but scientific service is to be found; but, hard or easy, it is on the shoulders of general science to present a motive that will make service the daily keynote.

A *second* aim should be to show that scientific work done by a social organization counts for more than work by individual units. It is not enough to have a passion for work, one must have a passion for *cooperative* work. Laboratory work in class room, in field, or city streets, must train pupils "to work like the ants or bees in a colony, where each individual is free to serve as best it can, but under the control of the colony, or with the spirit of the hive."* In what better way can young people be taught that the essential feature of biological progress consists in the subordination of minor units to the larger units of organization? Make the actual laboratory experiment individualistic as far as possible, but make its application in the spirit of the hive, or, we might say, in the spirit of the trenches. See to it that the pupils observe that "for every individual which survives by a keenly competitive life, a dozen can be found that are united in such social activities and general provisions for the species that the common well-fare of each individual is nearly always assured."** They will soon comprehend

*Conklin—Biology and Democracy. April, Scribner's Magazine.

that "co-operative and social survival and evolution" improve the individual and the race more than the "struggle for existence" and the "survival of the fittest." Such common animals as the dog and cat will serve as illustrations here. I want to make perfectly plain that in all I say, I am taking the biological point of view rather than the strictly ethical or moral. As a member of a race I am more willing to pay an income tax than as an individual. If I were merely the latter, I should prefer to give my money for the war in my own way.

The *third* aim should be to teach by practice with common things the scientific method and to develop the scientific point of view. Any material, when impartially secured, orderly arranged, logically interpreted and sympathetically built up will serve this purpose, providing of course, that it satisfies the preceding aims. If in the study of market, grocery store, saloon, clothing, food, the pupil tries to be guided by evidence rather than by emotion, by reason rather than by instinct, by knowledge rather than by sentiment, the process and result are as truly scientific as those used in any old type laboratory drill. I well recall a dispute that arose in a Sigma Xi meeting over the proposed election of an "educator" to membership. Could, the objectors said, any reasonable connection exist between a scientist and an educator? And was an educator ever scientific? It was only when the proposed member's educational activities were shown to be mathematical and statistical that he was admitted to the fold. "Every human being is a biologist in so far as he daily experiences environmental agents by which he is affected and to which he makes response."** Every human being is a scientist in so far as he observes events that he ascribes to their causes:—to the home, to friends, to the outside world; it is for the general science teacher to direct and to accelerate these functions and to turn them into immediate use to the individual and to the community.

Fourth aim should be to show the leaps and bounds in progress that can be brought about by specialists and specialization. Reports on the life and works of Edison, Carrel, Richards, Burbank, Wilbur and Orville Wright, Steinmetz, and men and women in the student's own community are exceedingly valu-

** See Macfarlane's, "The Causes and Course of Organic Evolution".

able for this. Each pupil should get from his science work, the idea that there is some *one* field in which he can yield the maximum service and should be inspired to work toward specialization in that field, even though it can be but a field of wheat or of typewriters. What is vocational guidance but the recognition of specialization in organisms and the fostering of it in individuals?

General science then aims to create a student science training corps in which each unit serves while he trains. His services are directed by officers, and may therefore be scientific although amateurish in character.

The duties of each member of the student science training corps consist in

1. Daily improvement of some form of the race environment. This may be so simple a matter as the better ventilation of a building, or the utilization of the cans for waste on the city streets.
2. Conscious subordination of the unit to the social organization for the better carrying out of the service suggested by the officers.
3. Development of the scientific spirit of keen observation, proper deduction, fair judgments, helpful constructions with something of the *spirit and speed that was shown by the S. A. T. C. in the development of war spirit.*
4. Reasonable effort by the unit and organization to apply the principles of selective draft, in deciding upon the form of scientific service that it can render.

General Science Meetings

The GENERAL SCIENCE CLUB OF NEW ENGLAND held its sixth regular meeting, June 7, in the High School of Practical Arts, Boston, with the following program.

"How General Science Teachers may assist in the agriculture movement." F. E. Heald, State Agt. in Agriculture Teacher Training.

"Little Things and Big Things." J. C. Packard, High School, Brookline.

"How Life Begins." A series of motion picture films shown and explained by Dr. G. Clyde Fisher, Ass't Curator American Museum of Natural History, New York.

"What a Fifteen Year Old Child Should Know About Heat." A. M. Butler, High School of Practical Arts, Boston.

"What a Fifteen Year Old Child Should Know About Hygiene." L. L. Workman, Normal School Framingham.

"What a Fifteen Year Old Child Should Know About Plant Life." Lillian J. MacRae, High School, South Boston.

"What a Fifteen Year Old Child Should Know About Garden Pests." W. H. D. Meier, Normal School, Framingham.

"Gardening: Motion Picture." Alfred MacDonald, Supervisor of Nature Study, Newton.

The following officers were elected for the next year.
President: J. Richard Lunt, Boston English High School.
Vice-Pres: W. H. D. Meier, Framingham Normal School.
Secretary: Edith L. Smith, Boston Normal School.
Treasurer: C. H. Stone, Boston English High School.

The above with the three following make up the executive committee.

S. E. Marvell, New Bedford High School.
Preston Smith, Fitchburg Normal School.
A. W. Taylor, Salem High School.

PROGRAM, GENERAL SCIENCE SECTION,
CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.
Lake View High School, Chicago, Illinois,
November 28 and 29, 1919.

Friday, November 28, 1:00 p. m.

1. "Air Conditioning in Modern School Buildings"..... Mr. S. R. Lewis, Consulting Engineer, Chicago, Illinois.
2. "Use of Physical Equipment of Home and School Building in Classroom Instruction"...................... Dean E. S. Keene, North Dakota Agricultural College.
3. "Possibilities of Home Work in General Science"..... Prof. G. A. Bowden, University School, Cincinnati, Ohio.
4. "Some Tangible Results from a General Science Course" Mr. George Mounce, LaSalle-Peru Twp. H. S. LaSalle, Illinois.
5. Report of Committee on Reorganization of Science in the High School...Secretary of the Section, Miss Ada Weckel
6. Business. Appointment of Committees.

Saturday, November 29, 10:00 a. m.

1. "The Role of Laboratory Work in General Science and the Teacher Training Involved"................... Prof. Herbert Brownell, Univ. of Nebraska, Lincoln, Neb.
2. "General Science in the High School of Tomorrow" Mr. J. Calvin Hanna, Supervisor of High Schools, Springfield, Ill.
3. "Relation of General Science to the Smith-Hughes Courses" Prof. A. W. Nolen, Univ. of Illinois, Urbana, Illinois.
4. Discussion of the Reorganization of Science Courses and of the Work for the Next Year.

Is "Suction" a Push or a Pull?

J. C. Packard, High School, Brookline, Mass.

Experiment 1. (a) Tie a rubber membrane tightly over the large end of a thistle tube. Apply the lips at the other end and gently exhaust the air from the inside of the tube.

(b) Wet the surface of a flat piece of glass. Press the end of the thistle tube,[1] still covered with the rubber membrane, tightly against the glass and exhaust again.

Experiment 2. (a) Close a glass bottle, half full of water, with a rubber stopper pierced by two glass tubes long enough to reach down into the water and to extend a few inches above the stopper. Attach a rubber pipe to the upper end of one of the tubes. Apply the lips to the open end of the rubber pipe and gently exhaust the air from the tube.

(b) Fill the bottle, tubes and all, completely full of water. Close the upper end of one of the glass tubes tightly with the finger and again exhaust air from the other.

Observations and conclusions:

Book Reviews

Everyday Science. William H. Snyder—Allyn & Bacon. 551 pages, well illustrated.

This is a revision of "First Year Science" and is decidedly superior to that book. It doesn't attempt nor suggest anything in the way of problem study or project work. There is no index, but this will doubtless be added in a future edition.

Plant Production. Moore & Halligan—American Book Co., 428 pages, 210 illustrations, $1.44.

The Smith-Hughes law is responsible for many changes in agricultural education practices. Useful and practical instruction must be given. This book makes it possible to apply school-room instruction in agriculture to the school or home plot of ground. The *Home Projects* outlined in the different chapters are suggestive of much practical work which can be carried out by individual students. In the appendix are planting tables giving valuable data on the home flower and vegetable gardens.

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[1] The thistle tube must be selected with care. Use one whose lip will touch a plane surface all the way around.

A Source Book of Biological Nature Study. Elliott R. Downing —University of Chicago Press. 503 pages, 338 illustrations, $3.00.

This is true to its name a *source* book for teachers. It not only gives the valuable and interesting information about living forms which can be used in nature study classes, but it also gives directions for obtaining material to use. The scope of the work is indicated by the chapter heading:

Animals of Pond and Stream, Insects, Birds, Animal Companions, Wayside Flowers, Common Trees, Seeds & Seedlings, and Garden Spore-Bearers.

Throughout the book one is impressed with the emphasis given to the practical needs in life. General science teachers will find many helpful suggestions.

A Field and Laboratory Guide in Biological Nature Study. Elliott R. Downing, University of Chicago Press. 120 pages, $1.00.

This is a laboratory manual for prospective nature study teachers. Sections in the manual correspond to the different chapters of the Source Book by the same author. Particularly helpful to the teachers in the vicinity of Chicago are The Key to Common Weeds, The Key to Trees, and The Key to Birds. The greater part of the work suggested is however, of value to teachers in any part of the country. The experimental field work and collections suggested will find application in most cases in classes of children. This is the first of a series of field books for nature study soon to be published.

Notes on Qualitative Analysis. Louis Agassiz Test. Ginn and Company. Ninety-two pages, 80 cents.

This little volume is written to meet the needs of students who desire to take qualitative analysis, but who have not had a complete course in general chemistry. It gives the principles of the Ionic Theory and Mass Law and discusses reactions from that standpoint. The tables devised for analytical procedure are concise and time-saving. A list of 162 questions at the end gives a review of the work of the manual. The book should find a place in agricultural and technical courses as well as in regular college chemistry courses.

Outline studies on school garden, home garden and vegetable growing projects, O. J. Kern, 64 pages. Published by Division of Agricultural Education, University of California.

Written for teachers in the elementary schools of California to assist in the movement, to bring more boys and girls into direct contact with soil and plant life. Gives a very complete outline and detailed references to different books illustrated with diagrams and half tones.

Outline of course of instruction in agricultural nature study for the rural school of California, O. J. Kern, 56 pages. Published by Division of Agricultural Education, University of California.

The following groups of material are included:—

1. Human needs interests and activities
2. Plant life throughout the year
3. Animal life throughout the year
4. Natural phenomena and the inorganic world and soil studies.

Physiology and hygiene for the first six grades are also included in the human needs. Several lesson plans in agricultural nature study, by Miss K. L. Reid, are given as suggestive of methods of organization and presentation of material. The entire plan of the course has been carefully worked out and the material is presented in a new and interesting way.

Science Teaching in the Gary Public Schools. Otis W. Caldwell—General Education Board, N. Y. C. 125 pages, illustrated, 10c.

A report of the survey of the nature study and science work of the Gary schools. Particularly interesting are the tests used in scoring the pupils.

The School Science Review. Subscription 8s, 6d per year, 2s per copy. The first number of this new quarterly magazine was issued in June. The magazine contains an interchange of ideas of teachers on Science teaching problems. This number shows a leaning toward our General Science method for pupils below 15 yrs of age and we find one American General Science text advertised. It is the official publication of the Science Masters Association and is edited by G. H. J. Adlam, M. A., B. S. C., City of London School.

Free Books and Bulletins

Floods. Those teachers who are particularly interested in teaching about river floods in connection with weather or physiography study will find the book "The History of the Flood in 1913" most helpful. This large book contains hundreds of fine pictures and many maps covering the East Central States which suffered most from the flood. The supply of these books is limited but they will be sent free to teachers who can use them to advantage as long as the supply lasts. Apply to C. W. Garrett, Pennsylvania Lines West of Pittsburg, Union Station, Pittsburg, Pa.

Aluminum Booklet. "*From Mine to Market*" and a set of conductivity test wires will be sent upon request to the Aluminum Cooking Utensil Company, New Kensington, Pennsylvania.

BOOKLET. "*Shale Bed to Road Bed.*" The Metropolitan Paving Brick Company, Canton, Ohio.

Public Health Pamphlets. A series of pamphlets used in the fight against venereal disease, the following will be sent free on application to "Division of Venereal Disease, U. S. Public Health Service, Washington, D. C."

A. For young men
B. For the general public
C. For boys
D. For parents
E. For girls and young women
F. For educators.

CONQUEST OF THE TROPICS, by F. U. Adams—a finely illustrated book of 368 pp. The United Fruit Co. 131 State St., Boston, Mass.

BOOKLET. *The Food Value of the Banana.* Illus. The United Fruit Co., 131 State St., Boston, Mass.

The following pamphlets may be obtained from the BUREAU OF EDUCATION, Washington, D. C.

Health Education 1. *Wanted: Teachers for Child Health Service.*
" " 2. *Diet for School Child.*
" " 3. *Summer Health and Play School.*
" " 4. *Teaching Health.*

Also *Class Room Weight Record.*

Overdue Subscriptions

The QUATERLY cannot continue on its mailing list, longer, those whose Subscriptions have expired. Send $1.50 and your subscription will be extended 1 year from expiration. This is the only sure way to keep your files complete.

Science Articles in Current Periodicals

Aeronautics

All Aboard the Air-liner. Kæmpffert & Kienstbach. Pop. Sc. Mo. 95:3:77-81. Sept. 1919.

Parachuting from a Plane. Lit. Dig. 62:5:35. Aug. 16, 1919.

The Future of Trans-Atlantic Flying. Lit. Dig. 62:3:14. July 19, 1919.

The Modern Dirigible Balloon. Illus. V. W. Page. Ev. Eng. Mag. 7:281-283. Aug. 1919.

To Europe in a Flying Machine. Illus. Kæmpffert & Kienstbach. Pop. Sc. Mo. 95:1:71-77. July 1919.

Laying Out Air Ways and Terminals. Pop. Sc. Mo. 95:2:62-63. Aug. 1919.

Across the Atlantic in a Single Attempt. Illus. W. Kæmpffert 95:2:78-79. Aug. 1919.

Large Air Planes for Passenger Transport. Illus. V. W. Page. Ev. Eng. Mag. 7:349-359. Sept. 1919.

Why Aviators Fall. Lit. Dig. 61:8:24 May 24, 1919.

Freedom of the Skies Alexander McAdie. Sc. Am. 121:84. July 26, 1919.

The First Round-trip Trans-Atlantic Airship. Illus. Sc. Am. 121:86. July 26, 1919.

The Trans-Atlantic Dirigible. Sc. Am. 121:58. July 19, 1919.

Parachutes for Airplanes. Illus. Sc. Am. 121:32. July 12, 1919.

Agriculture

Are You Paying too much for Fertilizer? F. F. Rockwell. Country Life. 36:5:52-53. Sept. 1919.

Getting the Country Place Back to a Peace Basis. Illus. F. F. Rockwell. Country Life. 36:3:52-53. July 1919.

Balanced Stock Rations for Winter. Illus. F. F. Rockwell. Country Life. 36:2:60-61. June 1919.

Origin of American Agriculture. Illus. H. H. Spinden. Sc. Am. Sup. 88:120. Aug. 23, 1919.

An Artificial Fertilizer. Sc. Am. Sup. 88:95. Aug. 9, 1919.

Hybrid Vigor and Its Meaning. D. F. Jones. Sc. Am. 121:230. Sept. 6, 1919.

The Fruit Grower's Slight of Hand—Grafting. Sc. Am. Sup. 88:28. July 12, 1919.

Alcohol

The Inheritance of Alcoholism. R. A. Spæth. Good Health. 54:219-224 and 273-278. Apr. and May 1919.

Asbestos

Asbestos Mines in Quebec. Illus. W. F. Sutherland. Sc. Am. 121:315. Sept 27, 1919.

Astronomy

Exploring the Glories of the Firmament. Illus. W. J. Showalter. Nat. Geog. Mag. 36:153-181. Aug. 1919.

New Worlds to Conquer. Sc. Am. 121-54. Sept. 13, 1919.

The Nature of Comets. Illus. Isabelle M. Lewis. Elec. Exp. 7:312-313. Aug. 1919.

Interesting Phenomena of Gravitation. Isabelle M. Lewis. Elec. Exp. 7:398-410. Aug. 1919.

AUTOMOBILE
Steam Automobile, (Historical). Lit. Dig. 62:1:95. July 5, 1919.
Putting Auto Motor in Good Running Condition. Illus. V. W. Page. Ev. Eng. Mag. 7:279. Aug. 1919.
Automobile Tire Manipulation and Repair. Illus. V. W. Page. Ev. Eng. Mag. 7:334-336. Sept. 1919.

BEAVER
Marvels of Beaver Work. Illus. A. R. Dugmore. Country Life. 36:2:48-51. June 1919.

BIRDS
Herons. Illus. A. A. Allen. Am. For. 25:1229-1234. July 1919.
The Gulls and Terns. Illus. A. A. Allen. Am. For. 1291-1295. August 1919.

BOAT MOTORS
Mid-Season Repairs. Ev. Eng. Mag. 7:263. August 1919.
Running on Kerosene. Ev. Eng. Mag. 7:271. August 1919.

CAMOUFLAGE
(Four papers on Camouflage). Illus. Trans. Ill. Eng. Soc. 14:215-255. July 1919.

CENTRAL AMERICA
Shattered Capitals of Central America. Illus. Herbert J. Spinden. 35:185-212. Nat. Geog. Mag. Sept. 1919.

CHEMISTRY
What is a Chemical Element? Frederick Soddy. Sc. Am. Sup. 88:69. Aug. 2, 1919.

CITY PLANNING
Business and Beauty Combined in a Small-town Civic Center. Illus. James O. Heyworth. Am. City (T. & Co. ed.) 21:26. July 1919.

COLD STORAGE
Cold Storage of Food. Sc. Am. Sup. 88:150 and 178. Sept. 6 and 20, 1919.

COLOR
Some Interesting Color Phenomena. M. Luckiesh. Sc. Am. 121:135. Aug. 9, 1919.

COMPASS
When the Flying Machine Compass Goes Crazy. C. H. Claudy. Sc. Am. 121:204. Aug. 30, 1919.

CONFUCIUS
The Descendents of Confucius. Illus. Maynard Owen Williams. Nat. Geog. Mag. 35:253-266. Sept. 1919.

COPERNICUS
Copernicus A. D. Watson. Sc. Am. Sup. 88:206. Sept. 27, 1919.

CORK
Preparing Cork for Shipment. Illus. Sc. Am. Sup. 88:200. Sept. 27, 1919.

CREATIVE NATURE

Creative Nature. Good Health. 54:329. June 1919.

DAYLIGHT SAVING

Thrift and Sunlight. Sc. Am. 121:128. Aug. 9, 1919.

DISEASE

How Infection Travels. Lit. Dig. 62:1:88. July 5th, 1919.

DRUG HABIT

The Drug Disease. Lit. Dig. 61:10:28. June 7, 1919.

EARTHQUAKES

The Mechanics of Earthquakes. Sc. Am. Sup. 87:402. June 28, 1919.

ELECTRICITY

Better Electric Insulation. Lit. Dig. 62:11:25. Sept. 13, 1919.

Electrical Equipment in Pittsburgh High School. Am. City. 20:579-585. June 1919.

Switching from Gas to Electricity. Illus. S. DeBrie. Country Life. 36:3:90. July 1919.

ELECTRIC FURNACES

The Electric Furnace, its Development, Scope and Future. Illus. F. Rowlinson. Sc. Am. Sup. 88:132 and 180. Aug. 30 and Sept. 20, 1919.

ENGINES

Semi-Deisel Engines. H. F. Sheperd. Sc. Am. Sup. 88:142. Aug. 30, 1919.

Prime Mover of High Efficiency—The Still Engine. Illus. F. E. D. Acland. Sc. Am. Sup. 88:204. Sept. 27, 1919.

Steam and Internal Engines Combined. Sc. A. 121:318. Sept. 27, 1919.

FEET

What Bad Shoes Do to Good Feet. J. E. Wilson. Physical Culture. 42:1:50-56. July 1919.

FINGER PRINTS

Copying Finger Prints. Robert De Resillac-Rose. Sc. Am. Sup. 88:173. Sept. 13, 1919.

Finger Prints for Everybody. Lit. Dig. 62:3:26. July 19, 1919.

FIRES

Fire Departments in American Cities. Illus. Com'l Am. 16:2:47-49. August 1919.

The Planning of Water Works for Fire Protection. H. M. Blourquist. Am. City. 31:242-246. Sept. 1919.

Shipping Containers. (Fire Dangers). Jo. Ind. Eng. Chem. 11:674-682. July 1919.

Fighting Fire in the Country. W. D. Bruckloe. Country Life. 36:4:46. Aug. 1919.

Fire Hazards that Should Be Anticipated. William H. Murphy. Am. City (Town and Co. Ed.) 20:463. May 1919.

FIRE APPARATUS
Putting Out a Burning Oil Tank. Lit. Dig. 62:13:20. Sept. 27, 1919.
Respirators and Oxygen Breathing Apparatus for Fire Fighters. Am. City. 20:543. June 1919.

FIRE ENGINE
World's Largest Gasoline Fire Engine. Lit. Dig. 62:5:39. Aug. 2, 1919.

FLAX
For Seed or for Fiber? Illus. R. S. Skerrett. Sc. Am. Sup. 121:30. July 12, 1919.
The Strongest and most Durable Fiber. W. N. Boase. Sc. Am. Sup. 88:6 and 42. July 5 and 19, 1919.

FLOWERS
The Lillies of the Field. Illus. Francis M. Fultz. Sc. Am. Sup. 88:92. Aug. 9, 1919.

FLOWER GARDEN
American Plants for American Gardens. Illus. Louise B. Wilder. Country Life. 36:3:39-43. July 1919.
Irises for All Gardens. (Illus. in color). B. Y. Morrison. Country Life. 36:2:25-39. June 1919.

FOOD
The Secrets of Protein. Current Opinion. 67:39. July 1919.
The Nutritional Standard of Adolescence. Graham Lusk. Jo. Home Econ. 11:281-287. July 1919.
Rationing the fire Sufferers of Minnesota. Lucy Cordiner. Jo. Home Econ. 11:347-351. Aug. 1919.
Specific Nutritive Values. Sc. Am. Sup. 88:122. Aug. 23, 1919.

FORESTS
The Gardens of our Forests. Illus. Alice M. Cook. Am. For. 25:1329-1333. Sept. 1919.

FOREST FIRES
The Northwest's Worst Forest Fire. Am. For. 25:1259. Aug. 1919.
Prevention of Fighters Fire Losses. Illus. Smith Riley. 25:1260-1263. Aug. 1919.
Forest Destruction Prevented by Control of Surface Fires. J. A. Kitts. Am. For. 25:1264. Aug. 1919.

FOSSILS
Thirty Millions Years Ago. Illus. Sc. Am. 120:682. June 28, 1919.
Hunting Big Game of Other Days. Illus. Barnum Brown. Nat. Geog. Mag. 35:407-429. May 1919.

FROST
Frost in the United States (With Frost Maps) Robert De C. Ward. Sc. Am. Sup. 88:117. Aug. 23, 1919.

FUEL
Making Fuel from Oil and Powdered Coal. Illus. R. G. Skerrett. Illus. World. 31:837-839. Aug. 1919.

FUSIBLE
Fusible Metal. Illus. World 31:915. Aug. 1919.

GAMES
The Geography of Games. Illus. J. R. Hildebrand. Nat. Geog. Mag. 36:89-144. Aug. 1919.

GARDEN
Sculpture in the Garden. Illus. Jean de Strelecki. Garden Mag. 30:50-53. Sept. 1919.
Managing the Mid-Summer Garden for Winter Supplies. Adolph Kruhm. Garden Mag. 29:207. June 1919.

GAS ENGINE
Getting More Out of the Gas Engine. Illus. Pop. Sc. Mo. 95:3:71. Sept. 1919.

GLASS
Window Glass as a Factor in Human Evolution. R. E. Danforth. Sc. Mo. 8:537-541. June 1919.
American Optical Glass. Lit. Dig. 61:12:26. June 21, 1919.

GUNS
Regunning a Battle-ships Turrets. Illus. Sc. Am. 121:161. Aug. 16, 1919.

HEALTH
A Clean Town. J. V. Stevens. Am. City. 21:133-134. Aug. 1919.
Why American Cities Must Fight Insects. Dwight Pierce. Am. City. 21:146-148. Aug. 1919.
We Gasp for Blood not for Oxygen. Current Opin. 67:173.
Needless Terrors to the Human Heart. Current Opin. 67:37. July 1919.
The Failure of Fletcherism. Current Opin. 67:38. July 1919.
Born a Dope Fiend. Lit. Dig. 62:3:27. July 19, 1919.
Home Remedies and Patent Medicines. Lit. Dig. 62:1:86. July 5, 1919.
Music Prescriptions. Lit. Dig. 62:8:26. Aug. 23, 1919.
Keeping the Cities Clean. Illus. Fred Mason. Illus. World. 31:866-868. Aug. 1919.
Dirt and Disease. Lit. Dig. 62:10:127. Sept. 6, 1919.
The Sun Health and Heliotherapy. Guy Hinsdale. Sc. Mo. 9:253-262. Sept. 1919.
Is Man the Fittest of Animals? R. A. Spaeth. Good Health. 54:343-346. June 1919.

HEARING
Aids for the Deaf. F. Womack. Sc. Am. Sup. 88:157. Sept. 6, 1919.

HELIUM
Helium the New Balloon Gas. Illus. G. S. Rogers. Nat. Geog. Mag. 35:441-456. May 1919.
Bibliography of Helium. E. R. Weaver. Jo. Ind. and Eng. Chem. 11:682-688. July 1919.

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American City. The Tribune Building, N. Y. C. Monthly. Two editions. City and Town and County Editions. $3.00 a year, 35c a copy. The Science problems of city and rural communities are treated in numerous articles, well illustrated. A valuable student and teacher's reference.

American Forestry. Washington, D. C. Monthly. 25c a copy, $3.00 a year. Splendid pictures for plant and tree study.

Commercial America. Phila. Com'l Museum, Phila., Pa., $2.00 a year. Ill. Commercial production. New Inventions. Will interest Commercial geography and science teachers.

Current Opinion. 65 W. 36 St., N. Y. Monthly. 25c a copy, $3.00 a year. Has a regular department "Science and Discovery" containing articles of popular interest, adapted to pupil or teacher's use.

Country Life, The New. Garden City, N. Y. Monthly. 50c a copy, $5.00 a year. Stands at the head of publications dealing with life in the country. Special interest to the general reader and has many articles on gardening and plant study valuable for school use.

Electrical Experimenter. 233 Fulton St., N. Y. Monthly. 15c a copy, $1.50 a year. Ill. Popular articles on electrical subjects which fascinate elementary and high school pupils. Many suggestions for teachers.

Everyday Engineering Magazine. 33 W. 42 St., N. Y. Monthly. 10c a copy, $1.00 a year. Ill. Popular articles on science and mechanics. Much of it is simple enough for elementary pupils.

Garden Magazine. Garden City, N. Y. Monthly. 25c a copy, $2.00 a year. Ill. Helpful to amateur gardeners, teachers and pupils.

General Science Quarterly. Salem, Mass. Quarterly. 40c a copy, $1.50 a year. The only journal published devoted alone to science in the elementary and secondary schools. It tells what schools are doing in science, gives lesson plans, demonstrations, and an extensive bibliography of usable science articles in current periodicals.

Geographical Review, The. Broadway at 156th St., N. Y. 50c a copy, $5.00 a year. Devoted to scientific geography. Original maps and pictures. One department contains condensed items on topics of current interest.

Good Health. Battle Creek, Michigan. Monthly. $2.50 a year, 25c a copy. Reduced rate to Schools. A non-technical health magazine devoted to race-betterment and biologic living.

The Guide to Nature. Sound Beach, Conn. Monthly. 10c a copy, $1.00 a year. Ill. Of interest to elementary pupils and teachers of nature study.

Illustrated World. Drexel Ave. and 58th St., Chicago. Monthly. 15c a copy, $2.00 a year. Many short articles on applications of science and mechanics. Popular in style and attractive to elementary and high school pupils.

Journal of the Franklin Institute. Philadelphia, Pa. Monthly. 50c a copy, $5.00 a year. Ill. A technical journal. Contains many articles of value to science teachers.

Journal of Home Economics. 1121 Cathedral St., Baltimore. Monthly. 25c a copy, $2.00 a year. For teachers.

The Literary Digest. 354 Fourth Ave., N. Y. Weekly. 10c a copy $4.00 a year. Has a department "Science and Invention." Articles are mostly digests from other journals. They are popular in nature and suitable for high school pupils.

Journal of Industrial and Engineering Chemistry. Box 505, Washington, D. C. 60c a copy, $6.00 a year. A technical journal which contains much material which teachers can use. Monthly.

National Geographic Magazine. Washington, D. C. Monthly. 25c a copy, $2.50 a year. Best monthly journal for high grade pictures. Articles are of interest to general reader, pupils and teachers, as well as to geographers.

Nature Study Review. Ithaca, N. Y. Monthly. 15c a copy, $1.00 a year. An illustrated journal for teachers of nature study.

Physical Culture. 119 West 40th St. N. Y. C. Monthly. $2.00 a year, 20c a copy. Popular articles on health and physical development.

Popular Mechanics Magazine. Chicago. Monthly. 20c a copy, $2.00 a year. Short science items and articles well illustrated. Appeals strongly to elementary pupils. Suggests many construction projects.

Popular Science Monthly. 255 West 39th St. N. Y. C. Monthly. $2.00 a year, 20c a copy. A Review in text and pictures of the news of science and invention presented in a humanistic and inspirational way. Used as a supplement to text-books in many high schools. Valuable to science pupils and teachers.

Review of Reviews. 30 Irving Place, N. Y., N. Y. Monthly. $4.00 a year. An illustrated monthly covering world affairs. Contains many good articles bearing on science, suitable for class reports.

School Science and Mathematics. Chicago. Monthly. $2.50 a year. A teacher's journal. Includes many helpful suggestions.

Scientific American. Woolworth Building, N. Y. Weekly. 10c a copy, $5.00 a year. Has longer articles than the other popular science journals. Illustrated and is particularly valuable to high school science pupils and teachers.

Scientific American Supplement. Woolworth Building, N. Y. Weekly. 10c a copy, $5.00 a year. Rather technical, but the majority of articles are usable by science teachers and some of them will do for pupil reference. Illustrated.

Scientific Monthly. Garrison, N. Y. 30c a copy, $3.00 a year. Articles as a rule are more along lines of pure science. Much of value to teachers, articles can be read to advantage by many pupils.

Transactions of the Illuminating Engineering Society. 29 W. 39th St., N. Y. Monthly. 75c a copy, $5.00 a year. Technical. Many articles contain material which can be used in high school classes.

Woman's Home Companion. 381 Fourth Ave., N. Y. C. Monthly. $2.00 a year. Good articles on foods and homes.